Minimum Quantities of Gas Required Offshore

IMCA D050 Rev. 1.1
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Version History

Date	Reason	Revision
December 2023	Quality check; headers, footers & document map updated; reference and glossary sections added; no change to content	Rev. 1.1
March 2021	Updated to provide more comprehensive advice on appropriate minimum quantities for all the many sources of gas required to support a diving project across a range of industry recognised diving methods. New guidance on minimum requirements for decompression, therapeutic, BIBS, calibration, metabolic, escape, LSP, and HRF gas stocks included. Three new appendices added.	Rev. 1
September 2020	Text amended in Section 2.1 1) to clarify the minimum gas reserve requirements for surface orientated rescue dives.	Rev. 0.1
May 2012	Updated and published as IMCA D 050	Rev. 0
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1 Introduction

1.1 Scope

This guidance addresses the minimum amount of breathing medium (air or mixed gas) required to be kept at an offshore dive site before a dive commences and during it.

Where appropriate, figures for minimum quantities of gas are included in the guidance. However, due to the large number of variables involved, it is not possible to define appropriate minimum quantities for all the many sources of gas required to support a diving project in a single generic document. Project specific planning is required to assess the complete operational gas needs for a diving project, and so this document also contains advice on how to calculate the minimum gas quantities required depending on circumstances, i.e. by means of a risk assessment taking the project location, conditions, and work scope into account.

Once calculated, minimum gas quantities for specific projects should be specified within the contractor's Diving Project Plan (DPP).

1.2 Objectives

The objectives of this document are to:

- assist the diving contractor in preparing the Diving Project Plan
- ensure that the amounts of emergency air and gas held at the site have been carefully considered and calculated
- ensure that these amounts are displayed in dive control and in saturation/chamber control
- ensure that supervisors do not start a dive and that they cease diving if these amounts are reduced to below the identified minimum level.

This document is designed to achieve these objectives by providing diving contractors, supervisors and clients with operational guidance that is based on sound safety principles, and which highlights the need for:

- an adequate safety management system
- hazard identifications and an appropriate level of risk assessment.

1.3 Application

This guidance is intended to apply internationally, but it is recognised that some countries will have legislation that requires different standards or practices to be followed. Where local or national laws are more stringent than the advice contained herein, they will always take precedence over this guidance.

1.4 Variations

Attempting to formalise these minimum levels is difficult as they are heavily dependent on individual circumstances such as:

- dive system volume and configuration
- breathing mixtures used
- decompression schedules used
- depth of dive
- work rate
- environmental conditions at the site.

This note only provides guidance on the **absolute minimum levels** to be carried onboard. These minimum levels do not account for the gas supplies required for carrying out any operational tasks.

When determining minimum levels, it is important to follow manufacturers' instructions and apply a risk assessment approach to the calculations.

1.5 Calculation Error

It is recognised that the calculations used to determine these quantities depend on the gases obeying the ideal gas laws and that gases used in diving are not ideal. However, the safety margins imposed are great enough that any variation in the calculation is minor compared to the total quantity of gas held.

1.6 Useable Gas Quantities

The gas quantities shown in this document relate to the surface equivalent volume of gas which must be available to the divers. Whilst the effects of depth are calculated within these numbers the losses encountered in delivery through regulators and pipework, and of the gas supply remaining at pressure in storage cylinders, must be assessed for the actual dive system equipment and layout, and added to the tabulated values.

1.7 Helium Leakage

Helium and helium gas mixtures, due to the extremely small size of the helium atom, leak from storage cylinders even when precautions are taken to tighten fittings.

Due allowance therefore always needs to be made for leakage, when calculating minimum quantities of gas required at the start of a diving operation.

1.8 Gas Status

There are two types of gas stocks considered in this document:

1) reserve gas, which is provided for a particular application, and once provided remains unused until specifically required, e.g. therapeutic gas, and
2) consumable gas, which is provided for ongoing use and will vary in quantity available on use and re-supply.

Once a site is mobilised, and the reserve gases checked and confirmed, the site may continue to operate whilst at minimum stock levels. Consumable gases require constant monitoring and, if the gas levels reach the minimum values, diving should be stopped and decompression commenced.

1.9 Operational Losses

An additional 10% on the calculated values for consumable gases should be allowed to account for chamber losses and leakage.

2 Surface Orientated Diving (Air, Nitrox or Heliox)

2.1 General

There are many sources of gas required during a diving operation. This section addresses the gas required for surface diving operations and provides minimum limits on gas to have on site, either in quantity or on how it can be calculated depending on the circumstances. Surface diving by its nature consists of a series of relatively short periods under pressure for the divers and allows the diving operation to be halted relatively quickly. For this reason, many of the gas requirements for surface orientated diving are set during planning (e.g. emergency escape requirements) and recorded in the DPP. If the required gas is not present the dive cannot start – e.g. therapeutic gas.

2.2 Operational In Water Gases – Gas Type Consumable

The minimum operational gas requirements cannot be set out in a generic document due to the large number of variables involved and project specific planning is required to assess the operational gas needs for a diving project scope.

There must, however, be the following minimum gas supplies available, in addition to any gas requirements to carry out the work tasks, in order to allow a diving program to commence. Diving must be stopped if the gas supplies fall below these minimum levels.

2.3 Divers Personal Gas Reserve (Bailout) – Gas Type Reserve

All Working Divers must carry a personal gas reserve to provide sufficient endurance to allow the diver to return to a place of safety. This will normally mean that a calculation should be available showing that the capacity of the cylinder(s) at the depth of diving will allow breathing gas for 1 minute for every 10 metres of excursion umbilical deployed. This calculation should be carried out using 40 l/min as a minimum consumption.

2.3.1 Surface Tended Excursion Umbilicals

When divers are deployed on a surface tended umbilical, using for example a basket with the excursion umbilical returning to the surface, then the excursion distance is the length of the diver's umbilical that is deployed from the tender's position on surface.

2.3.2 Wet Bell Excursion Umbilical

For divers deployed from a wet bell, with a main umbilical and gas distributed from the wet bell panel to the diver's excursion umbilicals, the excursion distance is the length of excursion umbilical deployed.

2.4 Standby Rescue Diver Gases – Gas Type Reserve

Sufficient compressed gas always needs to be available for two thirty-minute rescue dives by the standby rescue diver to the full intended diving depth with the diver breathing at 40 l/min. This gas is to be kept as a reserve.

2.5 Diver Deployment System Gas – Gas Type Reserve

2.5.1 Basket Deployment systems

Each diver deployment basket should carry reserve gas sufficient, in the event of main gas failure, for the divers to be recovered to the surface without missing decompression stops.

In practice this requirement is usually met with baskets carrying a "J" bottle (floodable volume of 44.4 litres) reserve for each working diver charged to a minimum of 150 bar.

2.5.2 Wet Bells

Wet bell gas reserves will depend on the outfitting and the secondary gas supply source(s) to the divers. As a minimum, there will be a gas reserve on the wet bell to provide reserve in the event of main gas failure for the divers to be recovered to the surface without missing decompression stops, at a breathing rate of 40 l/min at ambient pressure. Consideration also requires to be given to the provision of suitable ppO_2 values throughout the recovery.

If the onboard gas is also one of the alternative gas sources for the working diver this gas volume will require to be enhanced accordingly

2.6 In Water Decompression Gas – Gas Type Consumable

Specific decompression gases, e.g. if in water oxygen decompression is the planned diving method in the DPP, sufficient oxygen for decompressing the maximum number of working divers in the water at the same time must be on site and immediately available prior to starting the dive. The specification and quantity of decompression gas supplies are dependent on the depth, duration of a dive, and number of divers and cannot be given a generic value. The project minimum in water decompression gases should be addressed in the DPP.

2.7 Surface Decompression Gases (Non Therapeutic) – Gas Type Consumable

Sufficient compressed air needs to be available to pressurise both locks of the deck decompression chamber to the maximum decompression depth (normally ≈ 15 metres) plus sufficient air for three complete surface decompression cycles.

Sufficient breathing quality oxygen needs to be available for the full number of oxygen breathing cycles for each working diver under pressure.

2.8 Calibration Gases – Gas Type Consumable

2.8.1 Air and Nitrox Diving

Calibration gases may not be required for air or nitrox diving as it may be possible to calibrate analysers with well-ventilated standard ambient air. Some analysers, however, may require calibration mixes, which should be verified as suitable for the analysers in use.

2.8.2 Surface Mixed Gas Diving

Surface mixed gas diving requires calibration gas for the analysers to cover the full range of the gases being used and these calibration gas mixes need to be verified as suitable for the analysers in use.

A typical set of calibration gases for operations to 75 msw is:

- 100% Helium
- 20% O_2 (balance He).

No minimum quantity of calibration gas is set as there is no commitment of the divers to depth requiring the analysers to be recalibrated. If the analysers cannot be calibrated prior to the dive then the dive cannot be carried out. Sufficient quantities of calibration gases should be carried to complete the anticipated project scope.

Consideration should be given to having two sources of each calibration gas on site, one designated for use and one as a spare. For short mobilisations or work scopes consideration should be given to providing two smaller bottles of calibration gas rather than one larger one.

2.9 Therapeutic Gases – Gas Type Reserve

Sufficient compressed air needs to be available to pressurise both locks of the deck decompression chamber to the maximum possible treatment depth (normally 50 metres) plus sufficient air for three complete surface decompression cycles.

There should be sufficient quantities of therapeutic gases to carry out treatment of a DCI during normal decompression based on the contractor's tables.

90m^3 (3200 cu ft) of breathing quality oxygen needs to be available for emergency treatment procedures at each decompression chamber which may be used for therapeutic purposes within the DPP.

2.10 Operational Personnel Escape Gases – Gas Type Reserve

Sufficient compressed air at a minimum availability of 40 l/min needs to be available for the diving support crew to operate in a vessel emergency situation to safely recover the divers to surface pressure and to make their way to the vessel's evacuation stations within the vessel's allotted abandonment time.

This requirement applies to each member of the diving support crew required to remain at their operational station at a vessel muster alarm.

This supply may be umbilical fed or a BA set. If the supply is umbilical fed a BA set must also be provided for each member of the support crew to provide a means of escape once the divers are safe and the support crew members are making their way to the evacuation stations. The durations should be calculated for the diving project and set out in the DPP.

2.11 Diver Transfer Oxygen – Gas Type Reserve

If the hyperbaric evacuation plan requires divers to evacuate from the stricken vessel with missed decompression and transfer to a standby chamber at another location, sufficient portable oxygen sets are required to allow compromised divers their own oxygen source throughout the evacuation, from the start of the evacuation until they are being re-pressurised at the standby chamber. The durations should be calculated for the diving project and set out in the DPP.

3 Closed Bell Diving

3.1 General

There are many sources of gas required during a diving operation. This section addresses the gas required for closed bell diving operations and provides minimum limits on gas to have on site, either as a quantity or as advice on how it can be calculated depending on the circumstances.

Closed bell operations allow divers to be maintained under pressure for prolonged periods of time, in some cases up to 28 days. The diving operations are of such duration that divers cannot usually evacuate the site in an emergency without remaining under pressure in a chamber during the departure from dive site and transportation to a place of safety for decompression. For this reason, many of the gas requirements for closed bell diving are set during planning (e.g. emergency escape requirements) and recorded in the DPP.

Before commencing diving certain quantities of gas should be available as described below. If the minimum levels of gas are not available, the dive must not commence and if any of the consumable gas stocks are reduced to the minimum allowable levels then decompression should be started immediately.

This section has been based on saturation diving techniques. Air/nitrox TUP diving is addressed under its own subsections with references to both surface orientated and closed bell diving as relevant.

3.2 Operational In Water Gases – Gas Type Consumable

Sufficient mixed gas should always be available at the start of a bell run to carry out the intended bell run plus the same quantity of gas should be held as a reserve. This gas will be in addition to the gas requirements in the following paragraphs. Gas carried onboard the bell or hyperbaric evacuation system (HES) in cylinders should not be included in these calculations.

3.3 Divers Personal Gas Reserve (Bailout) – Gas Type Reserve

All working divers must carry a personal gas reserve to provide sufficient endurance to allow the diver to return to a place of safety. This will normally mean that a calculation should be available showing that the capacity of the cylinder(s) at the depth of diving will allow breathing gas for 1 minute for every 10 metres of excursion umbilical deployed. This calculation should be carried out using 40 l/min as a minimum consumption.

The use of rebreather systems may provide a more compact and efficient personal gas reserve for deeper diving depths and in regions with legislative requirements based on a breathing rate in excess of 40 l/min or with a minimum time duration. A rebreather has a set duration at a specific depth and the minimum duration of the set must provide a minimum of 1 minute duration for every 10 metres of excursion umbilical deployed. The breathing rate does not need to be considered for a rebreather.

3.4 Surface Rescue Diver Gases – Gas Type Reserve

Dive systems relying on surface deployed diver intervention for emergency bell recovery require to have sufficient compressed gas available for two thirty-minute rescue dives to the full intended diving depth with the diver breathing at 40 l/min. This gas is to be kept as a reserve.

3.5 Closed Bell Onboard Gas

3.5.1 Oxygen – Gas Type Consumable

The oxygen carried on the bell can be used for making up the oxygen levels in the bell due to metabolic consumption during operations and to provide enough metabolic oxygen in an emergency for a 24 hour survival time. Enough oxygen requires to be provided at the start of a bell run for both requirements and the bell run must be aborted if the oxygen levels reduce to the reserve minimum required 24 hour emergency survival time level.

Sufficient oxygen must be available for metabolic consumption by the maximum number of divers at 0.5 l/min (surface equivalent volume) per diver for at least 24 hours at the end of a bell run. The dive system configuration, number of divers in the bell, oxygen cylinder floodable volume, operating pressure, and regulator specification are inputs to calculate the minimum oxygen reserve pressure required to allow for the minimum 24-hour emergency requirement. This value should be calculated for each individual dive system and noted in the operating procedures.

3.5.2 Working Diver – Gas Type Reserve

There must be an emergency supply of breathing gas carried on board sufficient to support each working diver plus the bellman outside the bell for a minimum of 30 minutes at a breathing rate of 40 l/min at the maximum depth of the diving operation.

The dive system configuration, number of divers in the bell and gas cylinder floodable volume, operating pressure, and regulator specification are inputs to calculate the minimum emergency diver breathing gas reserve pressure required to allow for the minimum 30-minute emergency requirement. This value should be calculated for each emergency diver breathing supply within an individual dive system and noted in the operating procedures.

3.6 Dive System Chamber Gases

3.6.1 Pressurisation Gas – Gas Type Consumable

Before the start of a saturation, there needs to be sufficient mixed gas available to be able to pressurise the system (including all deck chambers, bells and Hyperbaric Evacuation System (HES) components required for the envisaged operation) to the maximum intended storage depth, plus at least an equal amount as a reserve. During the operation, the reserve of mixed gas, sufficient to completely re-pressurise the system, should be maintained at all times.

3.6.2 Metabolic and Decompression Oxygen– Gas Type Consumable

There should be sufficient oxygen to allow for metabolic consumption by each diver throughout the saturation period, plus that required to maintain the ppO_2 during decompression. This quantity should be doubled for safety reasons and held in two separate banks.

The minimum oxygen consumption for metabolism is 0.5 l/min per diver surface equivalent volume.

During decompression, as the pressure reduces the oxygen content of the gas mix has to be increased to maintain a constant ppO_2. The calculation for this oxygen make-up during decompression is complex and is presented in Appendix 1, Section 2 *Maintenance of Oxygen Partial Pressure During Decompression.*

3.6.3 Living Chambers Emergency Breathing Supply – Gas Type Reserve

In saturation diving, there is always the possibility of the deck chamber atmosphere becoming fouled, due to smoke or other contaminants. In such circumstances the chamber occupants should use the built-in breathing system (BIBS), dumping the exhaust overboard while they transfer to another chamber or the main chamber atmosphere is cleansed or flushed out. Sufficient gas quantity should always be available to allow each diver four hours breathing on BIBS masks (ppO_2 400mbar – 1400mbar) at the deepest depth. This minimum value will depend on the dive system layout, number of divers, diving depth, and gas supply system and will need to be calculated for the specific dive system. Some of the mixes may fulfil the requirements for both chamber BIBS and therapeutic mixes.

Table 1: Chamber BIBS requirements per diver for shallowest and deepest depths

Depth		Heliox *O_2%*	*Total (20 l/min)*
Surface – 60 msw	(Surface – 200’)	20	5 m^3 – 34 m^3
30 msw – 130 msw	(100’ – 425’)	10	20 m^3 – 68 m^3
48 msw – 190 msw	(160’ – 625’)	7	28 m^3 – 96 m^3
190 msw – 300 msw	(625’ – 1000’)	2	96 m^3- 150 m^3

***Note**: The 10% mix overlaps with 20% and 7% and so may be optional.*

3.7 Calibration Gases – Gas Type Consumable

Closed bell diving does require calibration gas for the analysers to cover the full range of the gases being used. The preferred option is for the calibration gas content to reflect the operational parameters of the planned diving and storage depths. The following guidance gives an acceptable span range and these calibration gas mixes need to be verified as suitable for the analysers in use.

3.7.1 Calibration Gases to Maximum Diving Depth of 100 msw

A typical set of calibration gases for operations to 100 msw is:

- 100% Helium
- 10% O_2 and 1000 ppm CO_2 (balance He)
- 20% O_2 & 4000 ppm CO_2 (balance He).

3.7.2 Calibration Gases to Maximum Diving Depth of 300 msw

A typical set of calibration gases for operations to 300 msw is:

- 100% Helium
- 5% O_2 & 500 ppm CO_2 (balance He)
- 10% O_2 & 1000 ppm CO_2 (balance He)
- 20% O_2 & 4000 ppm CO_2 (balance He).

The quantity of calibration gas used is dependent on the diving system size and layout as well as the type and number of analysers used in the system.

The daily operational requirement of calibration gas should be calculated and a minimum requirement for the anticipated duration of the saturation dive should be available. If this level is reached the dive should be aborted and decompression commenced.

Consideration should be given to having two sources of each calibration gas on site, one designated for use and one as a spare. For short mobilisations or work scopes consideration should be given to providing two smaller bottles of calibration gas rather than one larger one.

3.8 Therapeutic Gases – Gas Type Reserve

The composition and use of therapeutic or treatment gases varies from company to company, dependent on their detailed operating procedures and the therapeutic tables used. Sufficient quantities of therapeutic gas for the depths involved need to be available to carry out any foreseeable treatments as detailed in the company's rules.

For this document, the therapeutic gas requirement tables have been based on providing a therapeutic supply of gas within the range of 1.5 to 2.5 bar ppO_2 at any depth.

There should be sufficient quantities of therapeutic gases to carry out treatment of a DCI during normal decompression based on the contractor's tables.

An example is shown in the table below of the quantities of therapeutic mixes required to undertake 4 x 30-minute cycles alternating with 5-minute chamber atmosphere breaks for six divers.

Table 2: Therapeutic mix for 6 divers (6 x ata x 20 l/min x 120 min at deepest depth)

Depth		Heliox O_2%	*Total (20 l/min)*
Surface – 15 msw	(Surface – 50')	100	36 m^3
15 msw – 31 msw	(50' – 100')	60	60 m^3
30 msw – 56 msw	(95' – 175')	37.5	96 m^3
53 msw – 94 msw	(170' – 300')	24	150 m^3
90 msw – 156 msw	(285' – 490')	15	240 m^3
140 msw – 240 msw	(440' – 750')	10	360 m^3
205 msw – 300 msw	(645' – 1000')	7	447 m^3

3.9 Operational Personnel Escape Gases – Gas Type Reserve

Sufficient compressed air at a minimum availability of 40 l/min always needs to be available for each member of the diving support crew who are required to remain at their operational station at a vessel muster alarm. This is to allow the divers to be recovered to a place of safety and permit the support crew to make their way to their allocated evacuation stations within the vessel's allotted abandonment time frame.

This supply may be umbilical fed or a BA set. If the supply is umbilical fed a BA set must also be provided for each member of the support crew to provide a means of escape once the divers are safe and the support crew members are making their way to the evacuation stations. The durations should be calculated for the diving project and set out in the DPP.

3.10 Diver Transfer Oxygen – Gas Type Reserve

If the hyperbaric evacuation plan requires divers to evacuate from the stricken vessel with missed decompression and transfer to a standby chamber at another location, sufficient portable oxygen sets are required to allow each compromised diver his own oxygen source throughout the evacuation, from the start of the evacuation until he is being re-pressurised at the standby chamber. The durations should be calculated for the diving project and set out in the DPP.

3.11 Hyperbaric Reception Facility (HRF) Requirements

The HRF is a saturation diving chamber complex and must comply with all relevant sub-sections in section 3 of this document.

An HRF may be set up at a specific location for a pre-determined diving project or in some cases held on standby at an emergency deployment location. The equipment and gas supplies need to be on site or managed under a robust hyperbaric evacuation plan to ensure all necessary equipment and consumables will arrive at the desired location in a timely manner. In such an instance the gas supplies may be stored on standby at the location designated in the hyperbaric evacuation plan.

An HRF must comply with the gas requirements of sections:

- 3.6 – Dive System Chamber Gases – except for a reduced quantity of BIBS gas (see Section 3.6.3) where only one hour for each diver in the HRF is required.[1] The quantities in Table 3.1 may then be adjusted accordingly.
- 3.7 – Calibration Gases (with the exception of intermediate calibration mix – see Appendix 2, Gas Check Sheet 5 for details)
- 3.8 – Therapeutic Gases
- 3.9 – Operational Personnel Escape Gases.

3.12 Life Support Package (LSP) – Gas Type Reserve

The life support package is an emergency facility that functions in a similar manner to the overall life support system on an offshore saturation system and provides additional services and redundancy whilst supporting a Hyperbaric Rescue Unit (HRU). The exact detail of the LSP will be dependent on the planning and risk assessment for the method of recovering the HRU and carrying out the decompression. In some circumstances the LSP may be already built into a specialised recovery vessel and in other cases may be needed only to provide support during transport of the HRU from the recovery site to a nominated HRF.

Note: A separate DESIGN document, IMCA D063 *DESIGN for Hyperbaric Rescue Unit Life Support Packages* identifies in more detail what is required for the LSP.

Where the objective for the LSP is to provide an extension to the autonomy of the HRU for interim support at a safe-haven or HRF location with no planned decompression, the guidance on what should be considered is listed below. However, the exact quantities are driven by HRU volume, depth, manning, and location.

3.12.1 Interim Support Pressurisation Gas and BIBS – Minimum Recommended Quantities

1 x 200 bar 16 rack of 98%/2% Heliox

1 x 200 bar 16 rack of Heliox (ppO_2 200 – 1400 mbar)

3.12.2 Interim Support Metabolic Oxygen – Minimum Recommended Quantities

1 x 200 Bar 16 rack of diving quality O_2

3.12.3 Calibration Gases (50ltr bottles) – Minimum Recommended Quantities

1 x 100% Helium – 200 bar

1 x 20% O_2 & 4000ppm CO_2 (balance He) – 200 bar

[1] The likelihood for divers to require extended periods on BIBS gas within an HRF is very low. The HRF does not face the possibility of contaminants being introduced from working operations or from bell runs. The planned duration of HRF use is minimal compared to an operational saturation dive. Control measures for equipment and consumables also minimise the possibility of contamination. One hour of BIBS gas is therefore considered adequate for each diver in the HRF as opposed to 4 hours in an operational setting.

3.12.4 Decompression Gas

Where the objective for the LSP is to give primary support for HRU decompression on a vessel of opportunity or at a designated safe haven, the requirements of 3.6.2 are calculated in accordance with Appendix 1, Section 2, utilising the HRU floodable volume (FV).

It may not be practical or possible for the LSP to contain all of the required gas and consumables for a full decompression, or for unforeseen events. In such a circumstance the equipment and gas supplies need to be managed under a robust hyperbaric evacuation plan to ensure all necessary equipment and consumables will arrive at the desired location in a timely manner. In such instance the gas supplies may be stored on standby at the location designated in the hyperbaric evacuation plan.

3.12.5 Therapeutic Gas

Therapeutic gas is important for decompression at hyperbaric evacuation decompression sites as the stresses, both physical and mental, of the evacuation process leaves the divers more prone to DCI. The therapeutic mix package should comply with Section 3.8.

3.13 Air/Nitrox TUP Diving

Air/nitrox TUP diving is an amalgamation of surface orientated diving and closed bell diving. In essence, it is a surface orientated methodology with the decompression carried out in a safe environment without the need to decompress and recompress as would be the case in surface oxygen decompression.

With this technique the breathing gas is air/nitrox and the divers return to surface pressure at the end of each dive period (bell run). The decompression is in an air environment using oxygen breathing periods.

The composition and use of therapeutic or treatment gases varies from company to company, dependent on their detailed operating procedures and the therapeutic tables used. This document is based on treatment using US Navy therapeutic table 6 with oxygen breathing periods. Companies using other therapeutic tables should ensure they have sufficient quantities of therapeutic gas for the depths involved to carry out any foreseeable treatments as detailed in the company's rules.

Air/nitrox TUP diving needs to comply with the following sections:

- 3.2 – Operational In Water Gases -except the breathing gas will be air/nitrox
- 3.3 – Divers Personal Gas Reserve (Bailout)
- 3.4 – Surface Rescue Diver Gases
- 3.5.1 – Closed Bell System Gas Reserve – Oxygen – Metabolic oxygen makeup during air diving is to be carried out by flushing the bell. The oxygen requirements in this section are for 24 hour survival in a trapped or lost bell scenario.
- 3.5.2 – Closed Bell System Gas Reserve – Working Diver
- 2.7 – Surface Decompression Gases – with the addition of air for pressurising the closed bell and trunkings

- 2.8.1 – Calibration Gases
- 2.9 – Therapeutic Gases
- 3.9 – Operational Personnel Escape Gases
- 3.10 – Diver Escape Oxygen

4 Conclusions

This document provides guidance to supervisors and others as to when diving operations should not be commenced due to inadequate gas or air reserves or when decompression should be commenced in a saturation operation due to diminishing gas reserves.

The quantities referred to are for guidance only and are the **absolute minimum.** A risk assessment should be undertaken for the diving project and this is likely to result in much greater quantities of gas being required to be maintained onboard to cover all eventualities.

5 References

IMCA D063 Diving Equipment Systems Inspection Guidance Note – DESIGN for Hyperbaric Rescue Unit (HRU) Life Support Packages (LSP)

6 Glossary

BA	Breathing apparatus
BIBS	Built-in breathing system
DCI	Decompression illness
DESIGN	Diving equipment systems inspection guidance note
DPP	Diving project plan
fsw	Feet of seawater
FV	Floodable volume (m^3)
He	Helium
HES	Hyperbaric evacuation system
HRF	Hyperbaric reception facility
HRU	Hyperbaric rescue unit
LSP	Life support package
msw	Metres of seawater
ppm	Parts per million
ppO_2	Partial pressure oxygen (bar)
RMV	Respiratory minute volumes
TUP	Transfer under pressure

Appendix 1: Gas Calculations

For assistance in calculating the minimum quantities required, as specified in this document, the following values may be of use. These are either proven figures or have been derived from reasonable assumptions based on many years of operating experience.

Note that breathing gas consumption rates are usually quoted as respiratory minute volumes (RMV). This is the volume of gas inhaled or exhaled from a person's lungs in one minute at surface pressure. The minimum quantities of gas required for diving purposes must always take depth into account, i.e. free volumes of gas need to be calculated, and:

Free gas volume = Consumption rate at surface pressure x Depth

1. Diver's Gas Consumption (in Water)

- Using open circuit equipment, the value varies between 20 to 60 litres (0.7 to 2.1 cu ft) per minute depending on the type of work. A mean value of 35 litres (1.25 cu ft)/minute can be assumed for normal work.
- Using reclamation systems, a mean value of 5 litres (0.18 cu ft)/minute can be assumed.
- When breathing in an emergency the diver's consumption will increase and it is necessary to use an elevated value. A mean value of 40 litres (1.5 cu ft)/minute can be assumed for an emergency scenario breathing rate.

***NB**: Certain global regions, regulatory authorities and company policies may stipulate or recommend other work and emergency breathing rates, i.e. 45 l/min, 62.5 l/min, etc.*

The diving contractor should ensure, through risk assessment and regional compliance, that they are using appropriate breathing rates for the purpose of emergency air and gas calculations.

2. Maintenance of Oxygen Partial Pressure During Decompression

The following equation can be used to provide an approximate value for the minimum quantity of oxygen required to maintain the desired oxygen partial pressure levels in a system during decompression:

$$\text{Minimum quantity of oxygen required} = \text{Ln (starting depth for decompression absolute pressure)} \times ppO_2 \times FV$$

where:

- Ln is the natural logarithm
- ppO_2 is the partial pressure of oxygen in bars, and
- FV is the floodable volume of the chamber in cubic metres.

The numbers inserted for the starting depth for decompression absolute pressure and the partial pressure of oxygen should be derived from the relevant values expressed in bars. The number inserted for the floodable volume should be the figure in cubic metres. The result of the calculation is expressed in cubic metres. The calculation should produce a conservative figure because it assumes a constant ppO_2 all the way to surface. Metabolic oxygen consumption is not included.

3. Volume of Chambers

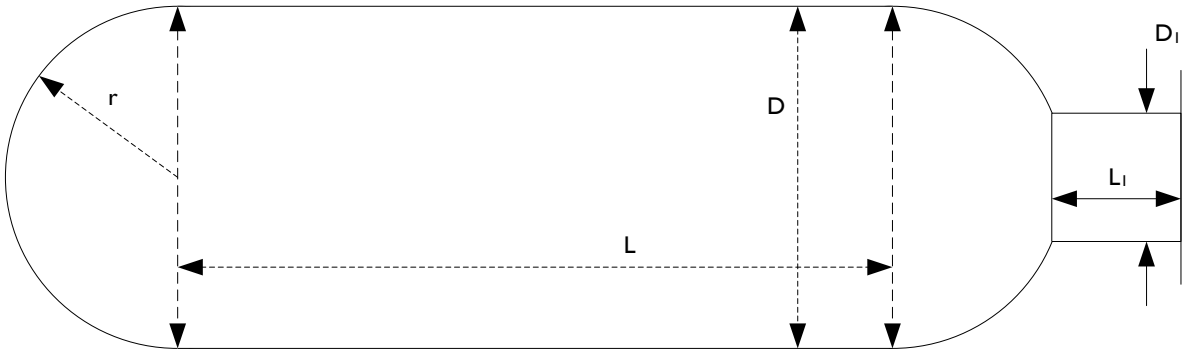

Figure 1: Dimensions of chamber

Volume of chamber = $(\pi(D/2)^2 \times L) + 4/3\ \pi r^3$, where the domed ends of the chamber are true spheres as shown above (in this case r = D/2). If the domed ends are oblate spheroids, then a more complex calculation would be required.

***NB**: The volume of each compartment, any trunking, spool pieces or food locks should be known and recorded to give total volume used when determining the required gas quantities. The volume of the spool piece in the simple example above is $\pi r_1^2 \times L_1$ where $r_1 = D_1/2$.*

4. Oxygen Metabolic Consumption (in Chambers)

- 0.5 litres (0.018 cu ft)/minute/diver.
- This equates to approximately 0.7 m^3 (25 cu ft)/day/diver.

5. BIBS Gas Consumption (at Surface Pressure)

- BIBS gas consumption is calculated at 20 litres (0.7 ft^3)/minute/diver.
- This equates to approximately 28.8 m^3 (1017 ft^3)/day/diver.

Appendix 2: Gas Requirements Check Sheets

This appendix provides a selection of example forms which may be used to plan and record the minimum diving gas requirements and provide the input for a gas management system for the diving project on site.

1. Surface Orientated Air or Nitrox Diving

Supply	Ref	Type	Defined Minimum	Calculated Qty	Qty On Site	Notes
Operational In Water Gas	2.2	Consumable	Project Defined			
Divers Personal Gas Reserve (Bailout)	2.3	Reserve	40 l/min at depth, 1 min for every 10m of excursion umbilical deployed			
Diver Rescue Gas	2.4	Reserve	2x30 min dives to max intended diving depth at 40 l/min at depth			
Wet Bell/Basket Gas	2.5	Reserve	Allow all divers to be recovered safely from longest and deepest planned diveat40 l/min at ambient pressure			
In Water Decompression Gas	2.6	Consumable	Project Defined			
Surface Decompression Gas	2.7	Consumable	Project Defined			
Calibration Gas	2.8.1	Consumable	Not required			
Therapeutic Gas	2.9.1	Reserve	90m^3 Oxygen			
Dive Crew Evacuation Gas	2.10	Reserve	Project Defined			
Diver Transfer Oxygen	2.11	Reserve	Project Defined			

2. Surface Orientated Mixed Gas Diving

Supply	Ref	Type	Defined Minimum	Calculated Qty	Qty On Site	Notes
Operational In Water Gas	2.2	Consumable	Project Defined			
Divers Personal Gas Reserve (Bailout)	2.3	Reserve	40 l/min at depth, 1 min for every 10m of excursion umbilical deployed			
Diver Rescue Gas	2.4	Reserve	2x30 min dives to max intended diving depth at 40 l/min at depth			
Wet Bell Gas	2.5	Reserve	Allow all divers to be recovered safely from longest and deepest planned diveat40 l/min at ambient pressure			
In Water Decompression Gas	2.6	Consumable	Project Defined			
Surface Decompression Gas	2.7	Consumable	Project Defined			
Calibration Gas	2.8.2	Consumable	Project defined			
Therapeutic Gas	2.9.2	Reserve	Project defined ref Table 2.1			
Dive Crew Evacuation Gas	2.10	Reserve	Project Defined			
Diver Transfer Oxygen	2.11	Reserve	Project Defined			

3. Gas Check Sheet – Closed Bell Air/Nitrox TUP Diving

Supply	Ref	Type	Defined Minimum	Calculated Qty	Qty On Site	Notes
Operational In Water Air	3.2	Consumable	Project Defined			
Divers Personal Air Reserve (Bailout)	3.3	Reserve	40 l/min at depth, 1 min for every 10m of excursion umbilical deployed			
Diver Rescue Air	3.4	Reserve	2x30 min dives to max intended diving depth at 40 l/min at depth			
Closed Bell Oxygen	3.5.1	Reserve	$1m^3$ surface equivalent per diver			
Closed Bell Onboard Air	3.5.2	Reserve	Project Defined			
Chamber BIBS	3.6.3	Reserve	Project Defined			
Chamber Pressurisation Air	2.7	Consumable	Project defined			
Calibration Gas	2.8.1		Not required			
Therapeutic Gas	2.9.1	Reserve	$90m^3$ Oxygen			
Dive Crew Evacuation Gas	2.10	Reserve	Project Defined			
Diver Transfer Oxygen	2.11	Reserve	Project Defined			

4. Gas Check Sheet – Saturation Closed Bell Diving

Supply	Ref	Type	Defined Minimum	Calculated Qty	Qty On Site	Notes
Operational In Water Gas	3.2	Consumable	Project Defined			
Divers Personal Gas Reserve (Bailout)	3.3	Reserve	40 l/min at depth, 1 min for every 10m of excursion umbilical deployed			
Diver Rescue Gas	3.4	Reserve	2x30 min dives to max intended diving depth at 40 l/min at depth			
Closed Bell Onboard Oxygen	3.5.1	Reserve	1 m^3 surface equivalent per diver			
Bell Onboard Breathing Gas Reserve	3.52	Reserve	Project Defined			
Chamber Pressurisation Gas	3.6.1	Consumable	Project Defined			
Chamber Metabolic Oxygen	3.6.2	Consumable	0.5 l/min per diver surface equivalent			
Chamber Decompression Oxygen	3.6.2	Consumable	Appendix 1 section 2			
Living Chamber BIBS	3.6.3	Reserve	Project defined			
Calibration Gas to 100msw	3.7	Consumable	100% Helium 10% O_2 & 1000 ppm CO_2 (balance He) 20% O_2 & 4000 ppm CO_2 (balance He).			

Gas Check Sheet – Saturation Closed Bell Diving (continued)

Supply	Ref	Type	Defined Minimum	Calculated Qty	Qty On Site	Notes
Calibration Gas to 300msw	3.7	Consumable	100% Helium 5% O_2 & 500 ppm CO_2 (balance He) 10% O_2 & 1000 ppm CO_2 (balance He) 20% O_2 & 4000 ppm CO_2 (balance He).			
Therapeutic Gas	3.8	Reserve	Ref Table 3.2			
Dive Crew Evacuation Gas	3.9	Reserve	Project Defined			
Diver Transfer Oxygen	3.10	Reserve	Project Defined			

Gas Check Sheet – Hyperbaric Reception Facility

Supply	**Ref**	**Type**	**Defined Minimum**	**Calculated Qty**	**Qty On Site**	**Notes**
Chamber Pressurisation Gas	3.6.1	Consumable	Project Defined			
Chamber Metabolic Oxygen	3.6.2	Consumable	0.5 l/min per diver surface equivalent			
Chamber Decompression Oxygen	3.6.2	Consumable	Appendix 1 section 2			
Living Chamber BIBS	3.6.3	Reserve	Project defined			
Calibration Gas to 100msw	3.7	Consumable	100% Helium 20% O_2 & 4000 ppm CO_2 (balance He).			
Calibration Gas to 300msw	3.7	Consumable	100% Helium 10% O_2 & 1000ppm CO_2 (balance He) 20% O_2 & 4000ppm CO_2 (balance He).			
Therapeutic Gas	3.8	Reserve	Ref Table 3.2			
Dive Crew Evacuation Gas	3.9	Reserve	Project Defined			

5. Gas Check Sheet – Life Support Package

Supply	Ref	Type	Defined Minimum	Calculated Qty	Qty On Site	Notes
HRU pressurisation support Gas	3.12.1	Reserve	1 x 200 bar 16 rack of 98%/2% Heliox 1 x 200 bar 16 rack of Heliox (PPO_2 200 – 1400 mbar)			
HRU metabolic oxygen support	3.12.2	Reserve	1 x 200 Bar 16 rack of diving quality O_2			
Calibration Gas	3.12.3	Reserve	1 x 100% Helium – 200 Bar 1 x 20% O_2 & 4000ppm CO2 (balance He) – 200 Bar			
HRU decompression Gas	3.12.4	Reserve	Ref 3.6.2			
Therapeutic Gas	3.12.5	Reserve	Ref table 3.2			

Appendix 3: Therapeutic Gas for Saturation Diving

This appendix provides details of oxygen partial pressures for different heliox mixes at different depths. There are two charts. The first shows ppO_2 values for depths between the surface and 300 metres of seawater (msw) in increments of one metre. The second shows ppO_2 values for depths between the surface and 1000 feet of seawater (fsw) in increments of five feet.

Diving contractors are responsible for selecting which diving tables they will use for both decompression and DCI treatment purposes. This appendix shows the oxygen partial pressures for the selected therapeutic mixes flagged as green in the range of 1.5 bar ppO_2 to 2.5 bar ppO_2. Below 1.5 bar ppO_2 the colouring is amber and above 2.5 bar ppO_2 the colouring is red.

It should be noted that it is not IMCA's intention, in this appendix or elsewhere, to specify a maximum ppO_2 limit for therapeutic breathing gases used in saturation or in surface diving operations. A range of 1.5 bar ppO_2 to 2.5 bar ppO_2 has been adopted in this appendix to illustrate that, using the selected heliox mixtures, it is possible to maintain oxygen partial pressures between 1.5 and 2.5 bar throughout the entire range of depths covered by the charts.

Diving contractors may select a slightly different saturation diving therapeutic gas ppO_2 range if its use is supported by a suitably expert and respected industry body. For example, the US Navy Diving Manual states that for saturation dives,

> *"Treatment gases having an oxygen partial pressure range of 1.5 to 2.8 shall be available in the event of decompression sickness."*

Certain industry recognised DCI treatment tables used in connection with surface diving operations will exceed 2.5 bar ppO_2. For example, during a US Navy Treatment Table 6 a diver breathing 100% oxygen at a depth of 60 fsw will be exposed to 2.8 bar ppO_2. It is of course perfectly acceptable to use such industry recognised DCI treatment tables.

Saturation Diving Therapeutic Gas ppO_2 Values (MSW)							
	O_2 %						
Depth	7	10	15	24	37.5	60	100
MSW	ppO_2 value			<1.5bar	1.5 to 2.5 bar		>2.5bar
0	0.1	0.1	0.2	0.2	0.4	0.6	1.0
1	0.1	0.1	0.2	0.3	0.4	0.7	1.1
2	0.1	0.1	0.2	0.3	0.5	0.7	1.2
3	0.1	0.1	0.2	0.3	0.5	0.8	1.3
4	0.1	0.1	0.2	0.3	0.5	0.8	1.4
5	0.1	0.2	0.2	0.4	0.6	0.9	1.5
6	0.1	0.2	0.2	0.4	0.6	1.0	1.6
7	0.1	0.2	0.3	0.4	0.6	1.0	1.7
8	0.1	0.2	0.3	0.4	0.7	1.1	1.8
9	0.1	0.2	0.3	0.5	0.7	1.1	1.9
10	0.1	0.2	0.3	0.5	0.8	1.2	2.0
11	0.1	0.2	0.3	0.5	0.8	1.3	2.1
12	0.2	0.2	0.3	0.5	0.8	1.3	2.2
13	0.2	0.2	0.3	0.6	0.9	1.4	2.3
14	0.2	0.2	0.4	0.6	0.9	1.4	2.4
15	0.2	0.3	0.4	0.6	0.9	1.5	2.5
16	0.2	0.3	0.4	0.6	1.0	1.6	2.6
17	0.2	0.3	0.4	0.6	1.0	1.6	2.7
18	0.2	0.3	0.4	0.7	1.1	1.7	2.8
19	0.2	0.3	0.4	0.7	1.1	1.7	2.9
20	0.2	0.3	0.5	0.7	1.1	1.8	3.0
21	0.2	0.3	0.5	0.7	1.2	1.9	3.1
22	0.2	0.3	0.5	0.8	1.2	1.9	3.2
23	0.2	0.3	0.5	0.8	1.2	2.0	3.3
24	0.2	0.3	0.5	0.8	1.3	2.0	3.4
25	0.2	0.4	0.5	0.8	1.3	2.1	3.5
26	0.3	0.4	0.5	0.9	1.4	2.2	3.6
27	0.3	0.4	0.6	0.9	1.4	2.2	3.7
28	0.3	0.4	0.6	0.9	1.4	2.3	3.8

Saturation Diving Therapeutic Gas ppO_2 Values (MSW)							
	O_2 %						
Depth	7	10	15	24	37.5	60	100
MSW	ppO_2 value			<1.5bar	1.5 to 2.5 bar		>2.5bar
29	0.3	0.4	0.6	0.9	1.5	2.3	3.9
30	0.3	0.4	0.6	1.0	1.5	2.4	4.0
31	0.3	0.4	0.6	1.0	1.5	2.5	4.1
32	0.3	0.4	0.6	1.0	1.6	2.5	4.2
33	0.3	0.4	0.6	1.0	1.6	2.6	4.3
34	0.3	0.4	0.7	1.1	1.7	2.6	4.4
35	0.3	0.5	0.7	1.1	1.7	2.7	4.5
36	0.3	0.5	0.7	1.1	1.7	2.8	4.6
37	0.3	0.5	0.7	1.1	1.8	2.8	4.7
38	0.3	0.5	0.7	1.2	1.8	2.9	4.8
39	0.3	0.5	0.7	1.2	1.8	2.9	4.9
40	0.4	0.5	0.8	1.2	1.9	3.0	5.0
41	0.4	0.5	0.8	1.2	1.9	3.1	5.1
42	0.4	0.5	0.8	1.2	2.0	3.1	5.2
43	0.4	0.5	0.8	1.3	2.0	3.2	5.3
44	0.4	0.5	0.8	1.3	2.0	3.2	5.4
45	0.4	0.6	0.8	1.3	2.1	3.3	5.5
46	0.4	0.6	0.8	1.3	2.1	3.4	5.6
47	0.4	0.6	0.9	1.4	2.1	3.4	5.7
48	0.4	0.6	0.9	1.4	2.2	3.5	5.8
49	0.4	0.6	0.9	1.4	2.2	3.5	5.9
50	0.4	0.6	0.9	1.4	2.3	3.6	6.0
51	0.4	0.6	0.9	1.5	2.3	3.7	6.1
52	0.4	0.6	0.9	1.5	2.3	3.7	6.2
53	0.4	0.6	0.9	1.5	2.4	3.8	6.3
54	0.4	0.6	1.0	1.5	2.4	3.8	6.4
55	0.5	0.7	1.0	1.6	2.4	3.9	6.5
56	0.5	0.7	1.0	1.6	2.5	4.0	6.6
57	0.5	0.7	1.0	1.6	2.5	4.0	6.7

Saturation Diving Therapeutic Gas ppO_2 Values (MSW)							
	O_2 %						
Depth	7	10	15	24	37.5	60	100
MSW	ppO_2 value			<1.5bar	1.5 to 2.5 bar		>2.5bar
58	0.5	0.7	1.0	1.6	2.6	4.1	6.8
59	0.5	0.7	1.0	1.7	2.6	4.1	6.9
60	0.5	0.7	1.1	1.7	2.6	4.2	7.0
61	0.5	0.7	1.1	1.7	2.7	4.3	7.1
62	0.5	0.7	1.1	1.7	2.7	4.3	7.2
63	0.5	0.7	1.1	1.8	2.7	4.4	7.3
64	0.5	0.7	1.1	1.8	2.8	4.4	7.4
65	0.5	0.8	1.1	1.8	2.8	4.5	7.5
66	0.5	0.8	1.1	1.8	2.9	4.6	7.6
67	0.5	0.8	1.2	1.8	2.9	4.6	7.7
68	0.5	0.8	1.2	1.9	2.9	4.7	7.8
69	0.6	0.8	1.2	1.9	3.0	4.7	7.9
70	0.6	0.8	1.2	1.9	3.0	4.8	8.0
71	0.6	0.8	1.2	1.9	3.0	4.9	8.1
72	0.6	0.8	1.2	2.0	3.1	4.9	8.2
73	0.6	0.8	1.2	2.0	3.1	5.0	8.3
74	0.6	0.8	1.3	2.0	3.2	5.0	8.4
75	0.6	0.9	1.3	2.0	3.2	5.1	8.5
76	0.6	0.9	1.3	2.1	3.2	5.2	8.6
77	0.6	0.9	1.3	2.1	3.3	5.2	8.7
78	0.6	0.9	1.3	2.1	3.3	5.3	8.8
79	0.6	0.9	1.3	2.1	3.3	5.3	8.9
80	0.6	0.9	1.4	2.2	3.4	5.4	9.0
81	0.6	0.9	1.4	2.2	3.4	5.5	9.1
82	0.6	0.9	1.4	2.2	3.5	5.5	9.2
83	0.7	0.9	1.4	2.2	3.5	5.6	9.3
84	0.7	0.9	1.4	2.3	3.5	5.6	9.4
85	0.7	1.0	1.4	2.3	3.6	5.7	9.5
86	0.7	1.0	1.4	2.3	3.6	5.8	9.6

Saturation Diving Therapeutic Gas ppO_2 Values (MSW)							
	O_2 %						
Depth	7	10	15	24	37.5	60	100
MSW	ppO_2 value			<1.5bar	1.5 to 2.5 bar		>2.5bar
87	0.7	1.0	1.5	2.3	3.6	5.8	9.7
88	0.7	1.0	1.5	2.4	3.7	5.9	9.8
89	0.7	1.0	1.5	2.4	3.7	5.9	9.9
90	0.7	1.0	1.5	2.4	3.8	6.0	10.0
91	0.7	1.0	1.5	2.4	3.8	6.1	10.1
92	0.7	1.0	1.5	2.4	3.8	6.1	10.2
93	0.7	1.0	1.5	2.5	3.9	6.2	10.3
94	0.7	1.0	1.6	2.5	3.9	6.2	10.4
95	0.7	1.1	1.6	2.5	3.9	6.3	10.5
96	0.7	1.1	1.6	2.5	4.0	6.4	10.6
97	0.7	1.1	1.6	2.6	4.0	6.4	10.7
98	0.8	1.1	1.6	2.6	4.1	6.5	10.8
99	0.8	1.1	1.6	2.6	4.1	6.5	10.9
100	0.8	1.1	1.7	2.6	4.1	6.6	11.0
101	0.8	1.1	1.7	2.7	4.2	6.7	11.1
102	0.8	1.1	1.7	2.7	4.2	6.7	11.2
103	0.8	1.1	1.7	2.7	4.2	6.8	11.3
104	0.8	1.1	1.7	2.7	4.3	6.8	11.4
105	0.8	1.2	1.7	2.8	4.3	6.9	11.5
106	0.8	1.2	1.7	2.8	4.4	7.0	11.6
107	0.8	1.2	1.8	2.8	4.4	7.0	11.7
108	0.8	1.2	1.8	2.8	4.4	7.1	11.8
109	0.8	1.2	1.8	2.9	4.5	7.1	11.9
110	0.8	1.2	1.8	2.9	4.5	7.2	12.0
111	0.8	1.2	1.8	2.9	4.5	7.3	12.1
112	0.9	1.2	1.8	2.9	4.6	7.3	12.2
113	0.9	1.2	1.8	3.0	4.6	7.4	12.3
114	0.9	1.2	1.9	3.0	4.7	7.4	12.4
115	0.9	1.3	1.9	3.0	4.7	7.5	12.5

Saturation Diving Therapeutic Gas ppO_2 Values (MSW)							
	O_2 %						
Depth	7	10	15	24	37.5	60	100
MSW	ppO_2 value			<1.5bar	1.5 to 2.5 bar		>2.5bar
116	0.9	1.3	1.9	3.0	4.7	7.6	12.6
117	0.9	1.3	1.9	3.0	4.8	7.6	12.7
118	0.9	1.3	1.9	3.1	4.8	7.7	12.8
119	0.9	1.3	1.9	3.1	4.8	7.7	12.9
120	0.9	1.3	2.0	3.1	4.9	7.8	13.0
121	0.9	1.3	2.0	3.1	4.9	7.9	13.1
122	0.9	1.3	2.0	3.2	5.0	7.9	13.2
123	0.9	1.3	2.0	3.2	5.0	8.0	13.3
124	0.9	1.3	2.0	3.2	5.0	8.0	13.4
125	0.9	1.4	2.0	3.2	5.1	8.1	13.5
126	1.0	1.4	2.0	3.3	5.1	8.2	13.6
127	1.0	1.4	2.1	3.3	5.1	8.2	13.7
128	1.0	1.4	2.1	3.3	5.2	8.3	13.8
129	1.0	1.4	2.1	3.3	5.2	8.3	13.9
130	1.0	1.4	2.1	3.4	5.3	8.4	14.0
131	1.0	1.4	2.1	3.4	5.3	8.5	14.1
132	1.0	1.4	2.1	3.4	5.3	8.5	14.2
133	1.0	1.4	2.1	3.4	5.4	8.6	14.3
134	1.0	1.4	2.2	3.5	5.4	8.6	14.4
135	1.0	1.5	2.2	3.5	5.4	8.7	14.5
136	1.0	1.5	2.2	3.5	5.5	8.8	14.6
137	1.0	1.5	2.2	3.5	5.5	8.8	14.7
138	1.0	1.5	2.2	3.6	5.6	8.9	14.8
139	1.0	1.5	2.2	3.6	5.6	8.9	14.9
140	1.1	1.5	2.3	3.6	5.6	9.0	15.0
141	1.1	1.5	2.3	3.6	5.7	9.1	15.1
142	1.1	1.5	2.3	3.6	5.7	9.1	15.2
143	1.1	1.5	2.3	3.7	5.7	9.2	15.3
144	1.1	1.5	2.3	3.7	5.8	9.2	15.4

Saturation Diving Therapeutic Gas ppO_2 Values (MSW)							
	O_2 %						
Depth	7	10	15	24	37.5	60	100
MSW	ppO_2 value			<1.5bar	1.5 to 2.5 bar		>2.5bar
145	1.1	1.6	2.3	3.7	5.8	9.3	15.5
146	1.1	1.6	2.3	3.7	5.9	9.4	15.6
147	1.1	1.6	2.4	3.8	5.9	9.4	15.7
148	1.1	1.6	2.4	3.8	5.9	9.5	15.8
149	1.1	1.6	2.4	3.8	6.0	9.5	15.9
150	1.1	1.6	2.4	3.8	6.0	9.6	16.0
151	1.1	1.6	2.4	3.9	6.0	9.7	16.1
152	1.1	1.6	2.4	3.9	6.1	9.7	16.2
153	1.1	1.6	2.4	3.9	6.1	9.8	16.3
154	1.1	1.6	2.5	3.9	6.2	9.8	16.4
155	1.2	1.7	2.5	4.0	6.2	9.9	16.5
156	1.2	1.7	2.5	4.0	6.2	10.0	16.6
157	1.2	1.7	2.5	4.0	6.3	10.0	16.7
158	1.2	1.7	2.5	4.0	6.3	10.1	16.8
159	1.2	1.7	2.5	4.1	6.3	10.1	16.9
160	1.2	1.7	2.6	4.1	6.4	10.2	17.0
161	1.2	1.7	2.6	4.1	6.4	10.3	17.1
162	1.2	1.7	2.6	4.1	6.5	10.3	17.2
163	1.2	1.7	2.6	4.2	6.5	10.4	17.3
164	1.2	1.7	2.6	4.2	6.5	10.4	17.4
165	1.2	1.8	2.6	4.2	6.6	10.5	17.5
166	1.2	1.8	2.6	4.2	6.6	10.6	17.6
167	1.2	1.8	2.7	4.2	6.6	10.6	17.7
168	1.2	1.8	2.7	4.3	6.7	10.7	17.8
169	1.3	1.8	2.7	4.3	6.7	10.7	17.9
170	1.3	1.8	2.7	4.3	6.8	10.8	18.0
171	1.3	1.8	2.7	4.3	6.8	10.9	18.1
172	1.3	1.8	2.7	4.4	6.8	10.9	18.2
173	1.3	1.8	2.7	4.4	6.9	11.0	18.3

Saturation Diving Therapeutic Gas ppO_2 Values (MSW)							
	O_2 %						
Depth	7	10	15	24	37.5	60	100
MSW	ppO_2 value			<1.5bar	1.5 to 2.5 bar		>2.5bar
174	1.3	1.8	2.8	4.4	6.9	11.0	18.4
175	1.3	1.9	2.8	4.4	6.9	11.1	18.5
176	1.3	1.9	2.8	4.5	7.0	11.2	18.6
177	1.3	1.9	2.8	4.5	7.0	11.2	18.7
178	1.3	1.9	2.8	4.5	7.1	11.3	18.8
179	1.3	1.9	2.8	4.5	7.1	11.3	18.9
180	1.3	1.9	2.9	4.6	7.1	11.4	19.0
181	1.3	1.9	2.9	4.6	7.2	11.5	19.1
182	1.3	1.9	2.9	4.6	7.2	11.5	19.2
183	1.4	1.9	2.9	4.6	7.2	11.6	19.3
184	1.4	1.9	2.9	4.7	7.3	11.6	19.4
185	1.4	2.0	2.9	4.7	7.3	11.7	19.5
186	1.4	2.0	2.9	4.7	7.4	11.8	19.6
187	1.4	2.0	3.0	4.7	7.4	11.8	19.7
188	1.4	2.0	3.0	4.8	7.4	11.9	19.8
189	1.4	2.0	3.0	4.8	7.5	11.9	19.9
190	1.4	2.0	3.0	4.8	7.5	12.0	20.0
191	1.4	2.0	3.0	4.8	7.5	12.1	20.1
192	1.4	2.0	3.0	4.8	7.6	12.1	20.2
193	1.4	2.0	3.0	4.9	7.6	12.2	20.3
194	1.4	2.0	3.1	4.9	7.7	12.2	20.4
195	1.4	2.1	3.1	4.9	7.7	12.3	20.5
196	1.4	2.1	3.1	4.9	7.7	12.4	20.6
197	1.4	2.1	3.1	5.0	7.8	12.4	20.7
198	1.5	2.1	3.1	5.0	7.8	12.5	20.8
199	1.5	2.1	3.1	5.0	7.8	12.5	20.9
200	1.5	2.1	3.2	5.0	7.9	12.6	21.0
201	1.5	2.1	3.2	5.1	7.9	12.7	21.1
202	1.5	2.1	3.2	5.1	8.0	12.7	21.2

Saturation Diving Therapeutic Gas ppO_2 Values (MSW)							
	O_2 %						
Depth	7	10	15	24	37.5	60	100
MSW	ppO_2 value			<1.5bar	1.5 to 2.5 bar		>2.5bar
203	1.5	2.1	3.2	5.1	8.0	12.8	21.3
204	1.5	2.1	3.2	5.1	8.0	12.8	21.4
205	1.5	2.2	3.2	5.2	8.1	12.9	21.5
206	1.5	2.2	3.2	5.2	8.1	13.0	21.6
207	1.5	2.2	3.3	5.2	8.1	13.0	21.7
208	1.5	2.2	3.3	5.2	8.2	13.1	21.8
209	1.5	2.2	3.3	5.3	8.2	13.1	21.9
210	1.5	2.2	3.3	5.3	8.3	13.2	22.0
211	1.5	2.2	3.3	5.3	8.3	13.3	22.1
212	1.6	2.2	3.3	5.3	8.3	13.3	22.2
213	1.6	2.2	3.3	5.4	8.4	13.4	22.3
214	1.6	2.2	3.4	5.4	8.4	13.4	22.4
215	1.6	2.3	3.4	5.4	8.4	13.5	22.5
216	1.6	2.3	3.4	5.4	8.5	13.6	22.6
217	1.6	2.3	3.4	5.4	8.5	13.6	22.7
218	1.6	2.3	3.4	5.5	8.6	13.7	22.8
219	1.6	2.3	3.4	5.5	8.6	13.7	22.9
220	1.6	2.3	3.5	5.5	8.6	13.8	23.0
221	1.6	2.3	3.5	5.5	8.7	13.9	23.1
222	1.6	2.3	3.5	5.6	8.7	13.9	23.2
223	1.6	2.3	3.5	5.6	8.7	14.0	23.3
224	1.6	2.3	3.5	5.6	8.8	14.0	23.4
225	1.6	2.4	3.5	5.6	8.8	14.1	23.5
226	1.7	2.4	3.5	5.7	8.9	14.2	23.6
227	1.7	2.4	3.6	5.7	8.9	14.2	23.7
228	1.7	2.4	3.6	5.7	8.9	14.3	23.8
229	1.7	2.4	3.6	5.7	9.0	14.3	23.9
230	1.7	2.4	3.6	5.8	9.0	14.4	24.0
231	1.7	2.4	3.6	5.8	9.0	14.5	24.1

Saturation Diving Therapeutic Gas ppO_2 Values (MSW)							
	O_2 %						
Depth	7	10	15	24	37.5	60	100
MSW	ppO_2 value			<1.5bar	1.5 to 2.5 bar		>2.5bar
232	1.7	2.4	3.6	5.8	9.1	14.5	24.2
233	1.7	2.4	3.6	5.8	9.1	14.6	24.3
234	1.7	2.4	3.7	5.9	9.2	14.6	24.4
235	1.7	2.5	3.7	5.9	9.2	14.7	24.5
236	1.7	2.5	3.7	5.9	9.2	14.8	24.6
237	1.7	2.5	3.7	5.9	9.3	14.8	24.7
238	1.7	2.5	3.7	6.0	9.3	14.9	24.8
239	1.7	2.5	3.7	6.0	9.3	14.9	24.9
240	1.8	2.5	3.8	6.0	9.4	15.0	25.0
241	1.8	2.5	3.8	6.0	9.4	15.1	25.1
242	1.8	2.5	3.8	6.0	9.5	15.1	25.2
243	1.8	2.5	3.8	6.1	9.5	15.2	25.3
244	1.8	2.5	3.8	6.1	9.5	15.2	25.4
245	1.8	2.6	3.8	6.1	9.6	15.3	25.5
246	1.8	2.6	3.8	6.1	9.6	15.4	25.6
247	1.8	2.6	3.9	6.2	9.6	15.4	25.7
248	1.8	2.6	3.9	6.2	9.7	15.5	25.8
249	1.8	2.6	3.9	6.2	9.7	15.5	25.9
250	1.8	2.6	3.9	6.2	9.8	15.6	26.0
251	1.8	2.6	3.9	6.3	9.8	15.7	26.1
252	1.8	2.6	3.9	6.3	9.8	15.7	26.2
253	1.8	2.6	3.9	6.3	9.9	15.8	26.3
254	1.8	2.6	4.0	6.3	9.9	15.8	26.4
255	1.9	2.7	4.0	6.4	9.9	15.9	26.5
256	1.9	2.7	4.0	6.4	10.0	16.0	26.6
257	1.9	2.7	4.0	6.4	10.0	16.0	26.7
258	1.9	2.7	4.0	6.4	10.1	16.1	26.8
259	1.9	2.7	4.0	6.5	10.1	16.1	26.9
260	1.9	2.7	4.1	6.5	10.1	16.2	27.0

Saturation Diving Therapeutic Gas ppO_2 Values (MSW)							
	O_2 %						
Depth	7	10	15	24	37.5	60	100
MSW	ppO_2 value			<1.5bar	1.5 to 2.5 bar		>2.5bar
261	1.9	2.7	4.1	6.5	10.2	16.3	27.1
262	1.9	2.7	4.1	6.5	10.2	16.3	27.2
263	1.9	2.7	4.1	6.6	10.2	16.4	27.3
264	1.9	2.7	4.1	6.6	10.3	16.4	27.4
265	1.9	2.8	4.1	6.6	10.3	16.5	27.5
266	1.9	2.8	4.1	6.6	10.4	16.6	27.6
267	1.9	2.8	4.2	6.6	10.4	16.6	27.7
268	1.9	2.8	4.2	6.7	10.4	16.7	27.8
269	2.0	2.8	4.2	6.7	10.5	16.7	27.9
270	2.0	2.8	4.2	6.7	10.5	16.8	28.0
271	2.0	2.8	4.2	6.7	10.5	16.9	28.1
272	2.0	2.8	4.2	6.8	10.6	16.9	28.2
273	2.0	2.8	4.2	6.8	10.6	17.0	28.3
274	2.0	2.8	4.3	6.8	10.7	17.0	28.4
275	2.0	2.9	4.3	6.8	10.7	17.1	28.5
276	2.0	2.9	4.3	6.9	10.7	17.2	28.6
277	2.0	2.9	4.3	6.9	10.8	17.2	28.7
278	2.0	2.9	4.3	6.9	10.8	17.3	28.8
279	2.0	2.9	4.3	6.9	10.8	17.3	28.9
280	2.0	2.9	4.4	7.0	10.9	17.4	29.0
281	2.0	2.9	4.4	7.0	10.9	17.5	29.1
282	2.0	2.9	4.4	7.0	11.0	17.5	29.2
283	2.1	2.9	4.4	7.0	11.0	17.6	29.3
284	2.1	2.9	4.4	7.1	11.0	17.6	29.4
285	2.1	3.0	4.4	7.1	11.1	17.7	29.5
286	2.1	3.0	4.4	7.1	11.1	17.8	29.6
287	2.1	3.0	4.5	7.1	11.1	17.8	29.7
288	2.1	3.0	4.5	7.2	11.2	17.9	29.8
289	2.1	3.0	4.5	7.2	11.2	17.9	29.9

Saturation Diving Therapeutic Gas ppO_2 Values (MSW)							
	O_2 %						
Depth	7	10	15	24	37.5	60	100
MSW	ppO_2 value			<1.5bar	1.5 to 2.5 bar		>2.5bar
290	2.1	3.0	4.5	7.2	11.3	18.0	30.0
291	2.1	3.0	4.5	7.2	11.3	18.1	30.1
292	2.1	3.0	4.5	7.2	11.3	18.1	30.2
293	2.1	3.0	4.5	7.3	11.4	18.2	30.3
294	2.1	3.0	4.6	7.3	11.4	18.2	30.4
295	2.1	3.1	4.6	7.3	11.4	18.3	30.5
296	2.1	3.1	4.6	7.3	11.5	18.4	30.6
297	2.1	3.1	4.6	7.4	11.5	18.4	30.7
298	2.2	3.1	4.6	7.4	11.6	18.5	30.8
299	2.2	3.1	4.6	7.4	11.6	18.5	30.9
300	2.2	3.1	4.7	7.4	11.6	18.6	31.0

Saturation Diving Therapeutic Gas ppO_2 Values (FSW)							
	O_2 %						
Depth	7	10	15	24	37.5	60	100
FSW	ppO_2 value			<1.5bar	1.5 to 2.5 bar		>2.5bar
0	0.0	0.1	0.1	0.2	0.3	0.6	1.0
5	0.0	0.1	0.1	0.2	0.4	0.6	1.1
10	0.0	0.1	0.1	0.3	0.4	0.7	1.3
15	0.1	0.1	0.2	0.3	0.5	0.8	1.4
20	0.1	0.1	0.2	0.3	0.6	0.9	1.6
25	0.1	0.1	0.2	0.4	0.6	1.0	1.7
30	0.1	0.1	0.2	0.4	0.7	1.1	1.9
35	0.1	0.2	0.3	0.4	0.7	1.2	2.0
40	0.1	0.2	0.3	0.5	0.8	1.3	2.2
45	0.1	0.2	0.3	0.5	0.8	1.4	2.3
50	0.1	0.2	0.3	0.6	0.9	1.5	2.5
55	0.1	0.2	0.4	0.6	1.0	1.6	2.6
60	0.1	0.2	0.4	0.6	1.0	1.6	2.8
65	0.2	0.2	0.4	0.7	1.1	1.7	2.9
70	0.2	0.3	0.4	0.7	1.1	1.8	3.1
75	0.2	0.3	0.4	0.7	1.2	1.9	3.2
80	0.2	0.3	0.5	0.8	1.2	2.0	3.4
85	0.2	0.3	0.5	0.8	1.3	2.1	3.5
90	0.2	0.3	0.5	0.8	1.3	2.2	3.7
95	0.2	0.3	0.5	0.9	1.4	2.3	3.8
100	0.2	0.4	0.6	0.9	1.5	2.4	4.0
105	0.2	0.4	0.6	1.0	1.5	2.5	4.1
110	0.3	0.4	0.6	1.0	1.6	2.6	4.3
115	0.3	0.4	0.6	1.0	1.6	2.6	4.4
120	0.3	0.4	0.6	1.1	1.7	2.7	4.6
125	0.3	0.4	0.7	1.1	1.7	2.8	4.7
130	0.3	0.4	0.7	1.1	1.8	2.9	4.9
135	0.3	0.5	0.7	1.2	1.9	3.0	5.0
140	0.3	0.5	0.7	1.2	1.9	3.1	5.2

Saturation Diving Therapeutic Gas ppO_2 Values (FSW)							
	O_2 %						
Depth	7	10	15	24	37.5	60	100
FSW	ppO_2 value			<1.5bar	1.5 to 2.5 bar		>2.5bar
145	0.3	0.5	0.8	1.2	2.0	3.2	5.3
150	0.3	0.5	0.8	1.3	2.0	3.3	5.5
155	0.3	0.5	0.8	1.3	2.1	3.4	5.6
160	0.4	0.5	0.8	1.4	2.1	3.5	5.8
165	0.4	0.6	0.9	1.4	2.2	3.6	6.0
170	0.4	0.6	0.9	1.4	2.3	3.6	6.1
175	0.4	0.6	0.9	1.5	2.3	3.7	6.3
180	0.4	0.6	0.9	1.5	2.4	3.8	6.4
185	0.4	0.6	0.9	1.5	2.4	3.9	6.6
190	0.4	0.6	1.0	1.6	2.5	4.0	6.7
195	0.4	0.6	1.0	1.6	2.5	4.1	6.9
200	0.4	0.7	1.0	1.6	2.6	4.2	7.0
205	0.5	0.7	1.0	1.7	2.7	4.3	7.2
210	0.5	0.7	1.1	1.7	2.7	4.4	7.3
215	0.5	0.7	1.1	1.8	2.8	4.5	7.5
220	0.5	0.7	1.1	1.8	2.8	4.6	7.6
225	0.5	0.7	1.1	1.8	2.9	4.6	7.8
230	0.5	0.7	1.1	1.9	2.9	4.7	7.9
235	0.5	0.8	1.2	1.9	3.0	4.8	8.1
240	0.5	0.8	1.2	1.9	3.1	4.9	8.2
245	0.5	0.8	1.2	2.0	3.1	5.0	8.4
250	0.6	0.8	1.2	2.0	3.2	5.1	8.5
255	0.6	0.8	1.3	2.0	3.2	5.2	8.7
260	0.6	0.8	1.3	2.1	3.3	5.3	8.8
265	0.6	0.9	1.3	2.1	3.3	5.4	9.0
270	0.6	0.9	1.3	2.2	3.4	5.5	9.1
275	0.6	0.9	1.4	2.2	3.5	5.6	9.3
280	0.6	0.9	1.4	2.2	3.5	5.6	9.4
285	0.6	0.9	1.4	2.3	3.6	5.7	9.6

Saturation Diving Therapeutic Gas ppO_2 Values (FSW)							
	O_2 %						
Depth	7	10	15	24	37.5	60	100
FSW	ppO_2 value			<1.5bar	1.5 to 2.5 bar		>2.5bar
290	0.6	0.9	1.4	2.3	3.6	5.8	9.7
295	0.6	0.9	1.4	2.3	3.7	5.9	9.9
300	0.7	1.0	1.5	2.4	3.7	6.0	10.0
305	0.7	1.0	1.5	2.4	3.8	6.1	10.2
310	0.7	1.0	1.5	2.4	3.8	6.2	10.3
315	0.7	1.0	1.5	2.5	3.9	6.3	10.5
320	0.7	1.0	1.6	2.5	4.0	6.4	10.6
325	0.7	1.0	1.6	2.6	4.0	6.5	10.8
330	0.7	1.1	1.6	2.6	4.1	6.6	11.0
335	0.7	1.1	1.6	2.6	4.1	6.6	11.1
340	0.7	1.1	1.6	2.7	4.2	6.7	11.3
345	0.8	1.1	1.7	2.7	4.2	6.8	11.4
350	0.8	1.1	1.7	2.7	4.3	6.9	11.6
355	0.8	1.1	1.7	2.8	4.4	7.0	11.7
360	0.8	1.1	1.7	2.8	4.4	7.1	11.9
365	0.8	1.2	1.8	2.8	4.5	7.2	12.0
370	0.8	1.2	1.8	2.9	4.5	7.3	12.2
375	0.8	1.2	1.8	2.9	4.6	7.4	12.3
380	0.8	1.2	1.8	3.0	4.6	7.5	12.5
385	0.8	1.2	1.9	3.0	4.7	7.6	12.6
390	0.8	1.2	1.9	3.0	4.8	7.6	12.8
395	0.9	1.2	1.9	3.1	4.8	7.7	12.9
400	0.9	1.3	1.9	3.1	4.9	7.8	13.1
405	0.9	1.3	1.9	3.1	4.9	7.9	13.2
410	0.9	1.3	2.0	3.2	5.0	8.0	13.4
415	0.9	1.3	2.0	3.2	5.0	8.1	13.5
420	0.9	1.3	2.0	3.2	5.1	8.2	13.7
425	0.9	1.3	2.0	3.3	5.2	8.3	13.8
430	0.9	1.4	2.1	3.3	5.2	8.4	14.0

Saturation Diving Therapeutic Gas ppO_2 Values (FSW)							
	O_2 %						
Depth	7	10	15	24	37.5	60	100
FSW	ppO_2 value			<1.5bar	1.5 to 2.5 bar		>2.5bar
435	0.9	1.4	2.1	3.4	5.3	8.5	14.1
440	1.0	1.4	2.1	3.4	5.3	8.6	14.3
445	1.0	1.4	2.1	3.4	5.4	8.6	14.4
450	1.0	1.4	2.1	3.5	5.4	8.7	14.6
455	1.0	1.4	2.2	3.5	5.5	8.8	14.7
460	1.0	1.4	2.2	3.5	5.6	8.9	14.9
465	1.0	1.5	2.2	3.6	5.6	9.0	15.0
470	1.0	1.5	2.2	3.6	5.7	9.1	15.2
475	1.0	1.5	2.3	3.6	5.7	9.2	15.3
480	1.0	1.5	2.3	3.7	5.8	9.3	15.5
485	1.0	1.5	2.3	3.7	5.8	9.4	15.6
490	1.1	1.5	2.3	3.8	5.9	9.5	15.8
495	1.1	1.6	2.4	3.8	6.0	9.6	16.0
500	1.1	1.6	2.4	3.8	6.0	9.6	16.1
505	1.1	1.6	2.4	3.9	6.1	9.7	16.3
510	1.1	1.6	2.4	3.9	6.1	9.8	16.4
515	1.1	1.6	2.4	3.9	6.2	9.9	16.6
520	1.1	1.6	2.5	4.0	6.2	10.0	16.7
525	1.1	1.6	2.5	4.0	6.3	10.1	16.9
530	1.1	1.7	2.5	4.0	6.3	10.2	17.0
535	1.2	1.7	2.5	4.1	6.4	10.3	17.2
540	1.2	1.7	2.6	4.1	6.5	10.4	17.3
545	1.2	1.7	2.6	4.2	6.5	10.5	17.5
550	1.2	1.7	2.6	4.2	6.6	10.6	17.6
555	1.2	1.7	2.6	4.2	6.6	10.6	17.8
560	1.2	1.7	2.6	4.3	6.7	10.7	17.9
565	1.2	1.8	2.7	4.3	6.7	10.8	18.1
570	1.2	1.8	2.7	4.3	6.8	10.9	18.2
575	1.2	1.8	2.7	4.4	6.9	11.0	18.4

Saturation Diving Therapeutic Gas ppO_2 Values (FSW)							
	O_2 %						
Depth	7	10	15	24	37.5	60	100
FSW	ppO_2 value			<1.5bar	1.5 to 2.5 bar		>2.5bar
580	1.3	1.8	2.7	4.4	6.9	11.1	18.5
585	1.3	1.8	2.8	4.4	7.0	11.2	18.7
590	1.3	1.8	2.8	4.5	7.0	11.3	18.8
595	1.3	1.9	2.8	4.5	7.1	11.4	19.0
600	1.3	1.9	2.8	4.6	7.1	11.5	19.1
605	1.3	1.9	2.9	4.6	7.2	11.6	19.3
610	1.3	1.9	2.9	4.6	7.3	11.6	19.4
615	1.3	1.9	2.9	4.7	7.3	11.7	19.6
620	1.3	1.9	2.9	4.7	7.4	11.8	19.7
625	1.3	1.9	2.9	4.7	7.4	11.9	19.9
630	1.4	2.0	3.0	4.8	7.5	12.0	20.0
635	1.4	2.0	3.0	4.8	7.5	12.1	20.2
640	1.4	2.0	3.0	4.8	7.6	12.2	20.3
645	1.4	2.0	3.0	4.9	7.7	12.3	20.5
650	1.4	2.0	3.1	4.9	7.7	12.4	20.6
655	1.4	2.0	3.1	5.0	7.8	12.5	20.8
660	1.4	2.1	3.1	5.0	7.8	12.6	21.0
665	1.4	2.1	3.1	5.0	7.9	12.6	21.1
670	1.4	2.1	3.1	5.1	7.9	12.7	21.3
675	1.5	2.1	3.2	5.1	8.0	12.8	21.4
680	1.5	2.1	3.2	5.1	8.1	12.9	21.6
685	1.5	2.1	3.2	5.2	8.1	13.0	21.7
690	1.5	2.1	3.2	5.2	8.2	13.1	21.9
695	1.5	2.2	3.3	5.2	8.2	13.2	22.0
700	1.5	2.2	3.3	5.3	8.3	13.3	22.2
705	1.5	2.2	3.3	5.3	8.3	13.4	22.3
710	1.5	2.2	3.3	5.4	8.4	13.5	22.5
715	1.5	2.2	3.4	5.4	8.5	13.6	22.6
720	1.5	2.2	3.4	5.4	8.5	13.6	22.8

Saturation Diving Therapeutic Gas ppO_2 Values (FSW)							
	O_2 %						
Depth	7	10	15	24	37.5	60	100
FSW	ppO_2 value			<1.5bar	1.5 to 2.5 bar		>2.5bar
725	1.6	2.2	3.4	5.5	8.6	13.7	22.9
730	1.6	2.3	3.4	5.5	8.6	13.8	23.1
735	1.6	2.3	3.4	5.5	8.7	13.9	23.2
740	1.6	2.3	3.5	5.6	8.7	14.0	23.4
745	1.6	2.3	3.5	5.6	8.8	14.1	23.5
750	1.6	2.3	3.5	5.6	8.8	14.2	23.7
755	1.6	2.3	3.5	5.7	8.9	14.3	23.8
760	1.6	2.4	3.6	5.7	9.0	14.4	24.0
765	1.6	2.4	3.6	5.8	9.0	14.5	24.1
770	1.7	2.4	3.6	5.8	9.1	14.6	24.3
775	1.7	2.4	3.6	5.8	9.1	14.6	24.4
780	1.7	2.4	3.6	5.9	9.2	14.7	24.6
785	1.7	2.4	3.7	5.9	9.2	14.8	24.7
790	1.7	2.4	3.7	5.9	9.3	14.9	24.9
795	1.7	2.5	3.7	6.0	9.4	15.0	25.0
800	1.7	2.5	3.7	6.0	9.4	15.1	25.2
805	1.7	2.5	3.8	6.0	9.5	15.2	25.3
810	1.7	2.5	3.8	6.1	9.5	15.3	25.5
815	1.7	2.5	3.8	6.1	9.6	15.4	25.6
820	1.8	2.5	3.8	6.2	9.6	15.5	25.8
825	1.8	2.6	3.9	6.2	9.7	15.6	26.0
830	1.8	2.6	3.9	6.2	9.8	15.6	26.1
835	1.8	2.6	3.9	6.3	9.8	15.7	26.3
840	1.8	2.6	3.9	6.3	9.9	15.8	26.4
845	1.8	2.6	3.9	6.3	9.9	15.9	26.6
850	1.8	2.6	4.0	6.4	10.0	16.0	26.7
855	1.8	2.6	4.0	6.4	10.0	16.1	26.9
860	1.8	2.7	4.0	6.4	10.1	16.2	27.0
865	1.9	2.7	4.0	6.5	10.2	16.3	27.2

Saturation Diving Therapeutic Gas ppO_2 Values (FSW)							
	O_2 %						
Depth	7	10	15	24	37.5	60	100
FSW	ppO_2 value			<1.5bar	1.5 to 2.5 bar		>2.5bar
870	1.9	2.7	4.1	6.5	10.2	16.4	27.3
875	1.9	2.7	4.1	6.6	10.3	16.5	27.5
880	1.9	2.7	4.1	6.6	10.3	16.6	27.6
885	1.9	2.7	4.1	6.6	10.4	16.6	27.8
890	1.9	2.7	4.1	6.7	10.4	16.7	27.9
895	1.9	2.8	4.2	6.7	10.5	16.8	28.1
900	1.9	2.8	4.2	6.7	10.6	16.9	28.2
905	1.9	2.8	4.2	6.8	10.6	17.0	28.4
910	2.0	2.8	4.2	6.8	10.7	17.1	28.5
915	2.0	2.8	4.3	6.8	10.7	17.2	28.7
920	2.0	2.8	4.3	6.9	10.8	17.3	28.8
925	2.0	2.9	4.3	6.9	10.8	17.4	29.0
930	2.0	2.9	4.3	7.0	10.9	17.5	29.1
935	2.0	2.9	4.4	7.0	11.0	17.6	29.3
940	2.0	2.9	4.4	7.0	11.0	17.6	29.4
945	2.0	2.9	4.4	7.1	11.1	17.7	29.6
950	2.0	2.9	4.4	7.1	11.1	17.8	29.7
955	2.0	2.9	4.4	7.1	11.2	17.9	29.9
960	2.1	3.0	4.5	7.2	11.2	18.0	30.0
965	2.1	3.0	4.5	7.2	11.3	18.1	30.2
970	2.1	3.0	4.5	7.2	11.3	18.2	30.3
975	2.1	3.0	4.5	7.3	11.4	18.3	30.5
980	2.1	3.0	4.6	7.3	11.5	18.4	30.6
985	2.1	3.0	4.6	7.4	11.5	18.5	30.8
990	2.1	3.1	4.6	7.4	11.6	18.6	31.0
995	2.1	3.1	4.6	7.4	11.6	18.6	31.1
1000	2.1	3.1	4.6	7.5	11.7	18.7	31.3

Appendix 4: IMCA Diving Gas Supply Incident Reporting System

The diving industry is in a highly vulnerable position should mix-ups or other errors in the provision of diving gases occur. Divers breathe life-supporting gases at high pressures. If the wrong gases are delivered to diving contractors by diving gas supply companies, and incorrect gas mixtures are then provided to divers in chambers or in the water, the consequences may quickly be very serious.

In view of this, IMCA recommends that diving contractors always ensure they have robust arrangements in place at their dive sites to check that all pre-mixed diving gases received from gas supply companies contain the correct mixtures of breathing gas before they are put on-line.

In addition, IMCA operates a Diving Gas Supply Incident Reporting system which can be accessed through the IMCA website at: imca-int.com/information-notes/diving/gas-supply-incident-reporting.

The system contains a downloadable form which should be used to report:

- gas mix discrepancies; when the percentage of gas stated on the delivery slip, versus the percentage when analysed, differs significantly or to the extent where an accident or injury may occur, and
- other gas supply incidents; examples may include: incorrect colour coding or marking of quads or cylinders; excessive corrosion of quad frames, cylinders, valves and pipework; damaged lifting points etc.

The form also records:

- the region and country where the incident occurred
- whether any injury was sustained
- the name and address of the diving gas supplier
- comments and actions taken by the diving contractor.

Any supporting documentation, including photographs, should be attached to the report and returned to: divingreports@imca-int.com.

Reports will be monitored to identify concerns with particular gas supply companies or trends involving common incidents.